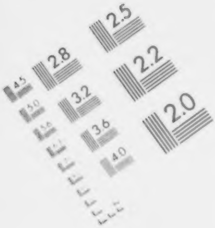
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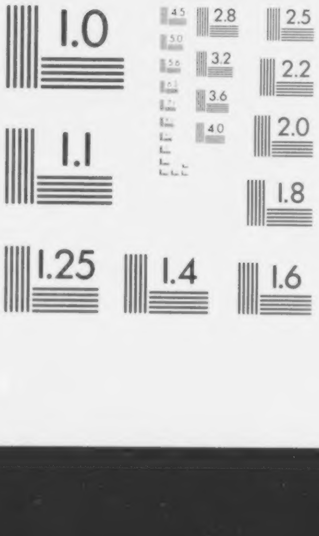
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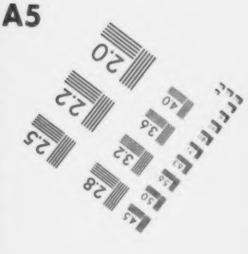
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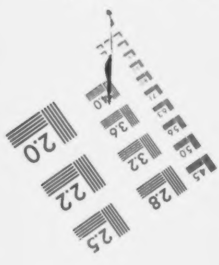
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ABSTRACT

Knowing the relationship of the ocean to man, the weather and climate, availability of resources from the ocean, use of the ocean in transporation, waste disposal, and defense, and developing an understanding of the impact on the oceans of human activity are all goals of oceanographers. The goal of this brochure is to provide concise informative answers to questions that education and information sources are often called upon to answer. The title was chosen to avoid confusion with other publications and to reflect the presentation format. The following questions are addressed: (1) "What Is an Oceanographer?"; (2) "Where Does One Study Oceanography?"; (3) "Who Hires Oceanographers?"; (4) "Who Supports Oceanographers?"; and (5) "Where Does One Obtain Information?" Listed are the names and addresses of publications and the 31 sea grant institutions which are additional sources of information about oceanography, ocean research and career opportunities. (RT)

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Questions about Careers in Oceanography

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Marine Education

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Department of Oceanography

87-401

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Questions about Careers in Oceanography

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TAMU-SG-87-401
January 1987

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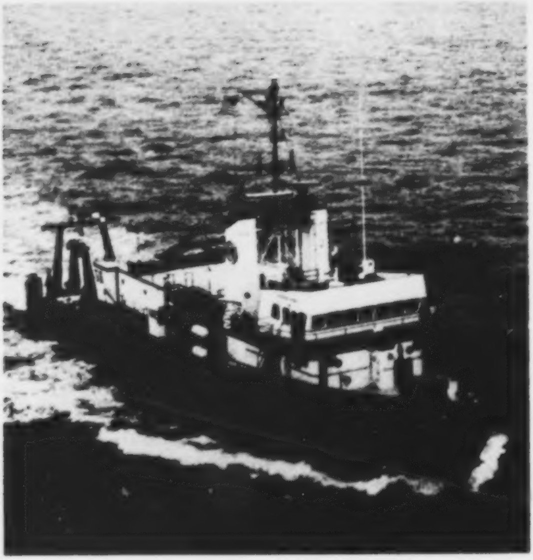
Aside

The forerunner to this brochure, ***Careers in Oceanography****, was written by Robert B. Abel and published in May 1979. Dr. Abel established the useful style of addressing several frequently encountered questions about careers in oceanography. This style of presentation is adopted in the present rewrite. The goal of this brochure is to provide concise but informative answers to those questions that education and information sources are often called upon to answer. The present title was chosen to reflect the presentation format and to avoid confusion with other recent publications.*

The brochure is directed to high school students, teachers and guidance counselors, and to college students with questions about careers in oceanography. The following questions, repeated from the original brochure, are addressed --

What is an oceanographer?
Where does one study oceanography?
Who hires oceanographers?
Who supports oceanographers?
Where does one obtain information?



What Is an Oceanographer?

Today, "Oceanographer" is a term that is usually understood to include ocean scientists, ocean engineers and ocean technicians.

Ocean scientists investigate how the oceans work. They usually have a graduate education in oceanography, but have studied one of the fundamental science fields at the undergraduate level, such as physics, chemistry, biology or geology. Ocean scientists take measurements and samples at sea, obtain "remote sensing" data from artificial earth satellites, perform laboratory measurements on samples, and conduct laboratory experiments, analyze data and perform simulations of ocean phenomena with numerical models on computers. The recognized subfields of oceanography are physical oceanography, chemical oceanography, biological oceanography, and geological and geophysical oceanography.

Physical oceanographers are concerned with the water masses and currents of the ocean, how the water masses are formed, and the driving forces that energize and shape the water's motion as currents or undulating waves. They study the interaction of many various forms of energy with the sea: light, radar, heat, sound and wind. They are interested in the interaction between the ocean and atmosphere, and the relationship between the sea, weather and climate.

Chemical ceanographers are interested in the distribution of chemical compounds and the many chemical interactions that occur in the ocean and the seafloor. The interactions among the sun's energy, atmospheric compounds, dissolved and suspended oceanic organic and inorganic material, sealife and the seafloor are studied. Also investigated is the impact on oceanic chemistry of both natural substances (such as natural seafloor petroleum seeps) and man-made material (such as waste or pollution).

Biological oceanographers seek to describe the many diverse forms of life in the sea, the patterns in their population densities and in their natural environment. They strive to understand how these animals and plants exist in complex interrelationships with other sea life, organic and inorganic substances, and energy and sources of energy in the seawater and seafloor. Also of interest is the impact of human modification of the environment on these living oceanic communities.

Geological and geophysical oceanographers describe the shape and material of the seafloor. They seek to understand the origin of seafloor sediments and rocks and the causes for the patterns in which they exist. These oceanographers attempt to relate their observations to phenomena as diverse as the movement of suspended sediment by currents in the ocean waters, the creation of new seafloor at midocean ridges and movement of vast plates of seafloor material and continents over millions of years, and to modification of the seafloor by biological processes and chemical interactions as well as pressure and heat.

As implied in these thumbnail sketches, the ocean scientist seldom exists in isolation, knowing and working only in a narrow specialty. Oceanographers are specialists--they must be because of the vast diversity of subjects coming under the umbrella term of oceanography. But almost any distribution of substances or properties, any mode of existence of a lifeform, any phenomenon or reaction occurring in the ocean is closely related to, or even controlled by, other features of the ocean. In order to understand one's own special area of interest, the oceanographer must have more than a passing knowledge of other areas of oceanography. Oceanographic studies usually are interdisciplinary and involve several ocean scientists with different specialities.

Ocean engineers function in several important roles in oceanography. First, they pursue their usual tasks, such as designing a structure, but the environment in which their design is to function is the sea. For example, the designer of a tower to stand on the sea floor on the offshore continental shelf and support oil well drilling equipment would apply many of the same design procedures that would be used to design such a tower to stand on the nearby land. How-

ever, the engineer designing the ocean-standing structure would be required to incorporate into the design much additional information about ocean currents and resulting structural forces, saltwater corrosion, marine life fouling and other similar factors. A second role of ocean engineers is the design of equipment and procedures to be used in making oceanographic measurements. This work is usually carried out best in close cooperation with ocean scientists. The ocean engineer today plays a significant role incorporating the innovative concepts from the forefront of the present explosion of technology into oceanographic instrumentation. In addition to design activities, ocean engineers are engaged directly in research. This is especially true in experimental studies of hydrodynamics and of seafloor sediment dynamics.

Ocean technicians play a vital role in oceanography. They are responsible for equipment calibration and preparation, measurements and sampling at sea, instrument maintenance and repair, and data processing. These technicians normally have a bachelor's degree, although some have associate's degrees resulting from two-year college programs.

Although most oceanographers receive their initial training in one of these fields of science or in engineering, many come from other backgrounds such as mathematics or meteorology. The subject of this brochure is oceanography as a career, but many other opportunities exist for work involving the ocean outside the realm of activity that is termed "oceanography." Lawyers, people trained in management, social scientists, economists, and experts in recreation, transportation, food, drugs, defense and waste disposal can and do make worthwhile contributions and pursue meaningful careers involving the ocean.

Additional information about oceanography careers is available in the brochure **Careers in Oceanography** produced by the American Geophysical Union (AGU). Information about a broader spectrum of marine-related careers is provided in **Ocean Opportunities**, a joint publication of the Marine Technology Society (MTS) and the Institute of Electrical and Electronics Engineers (IEEE).

Where Does One Study Oceanography?

Education in ocean science occurs primarily at the graduate level. Ocean engineering is studied at both the graduate and undergraduate levels. Careers as ocean scientists virtually require at least a master's degree, and many opportunities are primarily open to those with doctoral degrees. Undergraduate preparation for the study of oceanography is best obtained by pursuing an education in a science field closely related to one of the subfields of oceanography (physics, chemistry, biology, geology, geophysics) or in meteorology, mathematics or engineering. This can be done at any educational institution with strong programs in these fields. Degree programs are available for those who prefer to study marine science at the undergraduate level. A recent article (*Contemplating Tomorrow's Oceanographers* in the October 1985 issue of **Sea Technology**) states that nearly 80 schools nationwide offer undergraduate degrees in marine science. The article points out, however, that most of these degree programs are restricted in scope, with the majority focused on estuarine and intertidal biology. Two institutions with undergraduate programs of somewhat broader scope are the University of Washington at Seattle and Texas A&M University at Galveston. Individual courses in oceanographic subjects are offered at many universities, including those offering oceanography graduate degree programs.

The **Sea Technology** article goes on to say that about 50 institutions in the United States offer doctoral degrees in "various oceanographic disciplines." Ten of the largest U.S. oceanographic institutions form the Joint Oceanographic Institutions, Inc. These institutions are University of Hawaii, Lamont-Doherty Geological Observatory of Columbia University, University of Miami, Oregon State University, University of Rhode Island, Scripps Institution of Oceanography of the University of California, Texas A&M University, The University of Texas Institute for Geophysics, University of Washington and Woods

Hole Oceanographic Institution. Most of these offer degree programs leading to master's and doctoral degrees in all of the subfields of oceanography, including ocean engineering.

These ten educational and research institutions are also members of the University National Oceanographic Laboratory System (UNOLS), which also has seven other member institutions. The names and addresses of these additional member institutions, and those of 31 associate members of UNOLS, can be found in the previously mentioned **Careers in Oceanography** available from the AGU. An even more extensive list of schools offering courses of study in oceanography is provided in the brochure **Ocean Opportunities** available from IEEE or MTS. Detailed information about the degree programs for many of these schools also is provided in **University Curricula in Oceanography and Related Fields**, available from the U.S. Naval Oceanographic Office.

Who Hires Oceanographers?

Oceanographers work for the federal government, for private industry and for universities. They work in research, education, problem solving, and regulatory and administrative roles. Between 1976 and 1984, the average annual growth rate for ocean science and engineering employment was between five and ten percent. The most significant recent development in employment of oceanographers is related to the dramatic reduction in overall petroleum industry activity. A significant fraction of geological and geophysical oceanography graduates have typically found employment in this industry. Most projections indicate a continuing short-term lower employment in this industry, but better long-term opportunities when the exploration for and development of more difficult petroleum sources resumes. An over-supply of biological oceanographers in the last few years has been partially overcome by reduced enrollment in educational programs in this field.

Although there is no single source of information about employment opportunities in oceanography, there are a few sources that provide such information across a wide portion of the spectrum of opportunities. The American Geophysical Union publishes a weekly newspaper, **Eos**, that includes advertisements of employment opportunities, particularly in government and universities. Several technical journals carry similar advertisements. Many manufacturing companies with significant interest in the oceans advertise in **Sea Technology**, and reading recent editions of this magazine can provide information on those manufacturers who are currently active in the field. Other manufacturers and consulting firms and universities who are potential employers are listed among the corporate sponsors of the Marine Technology Society, and their names are listed in each issue of the Society's **Journal**.

Within the federal government, agencies that employ oceanographers include:

Department of Energy

Minerals Management Service, and
U.S. Geological Survey (Department of the Interior)
National Oceanic and Atmospheric Administration (Department of Commerce)
Naval Oceanographic Office, the Naval Ocean Research and Development Activity, and the Office of Naval Research (Department of the Navy)
National Science Foundation

University Curricula in Oceanography and Related Fields lists 194 universities and colleges that offer courses or degree programs in oceanography. Each is a potential employer of oceanographers with graduate degrees as educators. In addition to employing faculty members, many of these institutions, especially those with graduate programs, are possible employers of scientists wanting to engage in oceanographic research.

Who Supports Oceanographers?

Several of the organizations that support oceanography and oceanographers have been mentioned already as sources of additional information. These include the American Geophysical Union, the Marine Technology Society and the Institute of Electrical and Electronics Engineers/Oceanic Engineering Society.

There are several periodic meetings sponsored by one or more of these organizations, often with additional support from other organizations, where information about oceanography is exchanged in the form of technical papers. The AGU, for example, holds two meetings each year. The November 4, 1986, edition of **Eos** includes 417 pages of abstracts of papers presented at the Fall meeting. The Offshore Technology Conference (OTC) meets annually in Houston, Texas. The OTC is jointly sponsored by the Marine Technology Society, the Oceanic Engineering Society of IEEE and nine other institutes and societies. Both technical presentations and equipment exhibits are included at OTC meetings. A third major oceanographic exchange meeting is the annual Oceans XX Conference and Exposition, where the XX in the title reflects the last two digits of the year of the meeting. This series of meetings, which typically occur in the Fall, also is jointly sponsored by the Marine Technology Society and the Institute of Electrical and Electronics Engineers/Oceanic Engineering Society.

Two previously mentioned associations of the larger oceanographic institutions are the Joint Oceanographic Institutions, Inc. (JOI) and the University National Oceanographic Laboratory System (UNOLS). JOI is a consortium of ten major oceanographic institutions that was formed to provide advice and planning expertise for agencies funding oceanographic research. JOI also is involved in conducting some large oceanographic programs, such as serving as manager of the NSF Ocean Drilling Program.

UNOLS membership includes the ten members of JOI and seven other member and 31 associate member institutions. UNOLS is an association of institutions that operate major shared-use facilities, especially the ships of the oceanographic research fleet. A brochure, **The Research Fleet, The University National Oceanographic Laboratory System**, describes the ships and instruments of the UNOLS fleet and is available from:

UNOLS Office, WB-15
School of Oceanography
University of Washington
Seattle, Washington 98195
(206) 543-2203

Where Does One Obtain Information?

Publications mentioned elsewhere in this brochure and other information about oceanography can be requested from the following:

American Geophysical Union, Code E
2000 Florida Avenue NW
Washington, D.C. 20009
(**Careers in Oceanography** is available free of charge to individuals or in limited quantities to guidance counselors and teachers)

Publicity Committee or Membership Committee
Oceanic Engineering Society
Institute of Electrical and Electronics Engineers
345 East 47th Street
New York, N.Y. 10017-2394

Marine Technology Society
Suite 500
2000 Florida Avenue NW
Washington, D.C. 20009
(If ordering **Ocean Opportunities**, there is a $3.00 postage and handling charge)

Civilian Personnel Office
Naval Oceanographic Office
NSTL, Miss. 39522-5000
(**University Curricula in Oceanography and Related Fields** is available without charge to guidance counselors or teachers while existing supplies last.)

Sea Technology
Compass Publications, Inc.
Suite 1000
1117 N. 19th Street
Arlington, Va. 22209

Sea Grant Program Offices

The 31 Sea Grant institutions also are sources of information about oceanography, ocean research and career opportunities. Inquiries should be directed to the publications office at the following addresses:

Alaska Sea Grant College Program
590 University Avenue, Suite 102
University of Alaska
Fairbanks, Alaska 99709-1046

California Sea Grant CollegeProgram
University of California A-032
La Jolla, Calif. 92093

University of Southern California Sea Grant Program
Institute for Marine and Coastal Studies
University Park
Los Angeles, Calif. 90089-0341

University of Connecticut
Marine Advisory Service
Building 24, Room 110
Avery Point
Groton, Conn. 06340

Delaware Sea Grant College Program
College of Marine Studies
University of Delaware
Newark, Del. 19711

Florida Sea Grant College Program
G022 McCarty Hall
University of Florida
Gainesville, Fla. 32611

Georgia Sea Grant College Program
Ecology Building
University of Georgia
Athens, Ga. 30602

Hawaii Sea Grant College Program
University of Hawaii
1000 Pope Road, Room 201
Honolulu, Ha. 96822

Illinois/Indiana Sea Grant Program
University of Illinois at Urbana/Champaign
1301 W. Gregory Drive
51 Mumford Hall
Urbana, Ill. 61801

Louisiana Sea Grant College Program
Center for Wetland Resources
Louisiana State University
Baton Rouge, La. 70803

Maine Sea Grant Program
Marine Advisory Program
30 Coburn Hall
University of Maine
Orono, Me. 04469

Maryland Sea Grant College Program
H.J. Patterson Hall
University of Maryland
College Park, Md. 20742

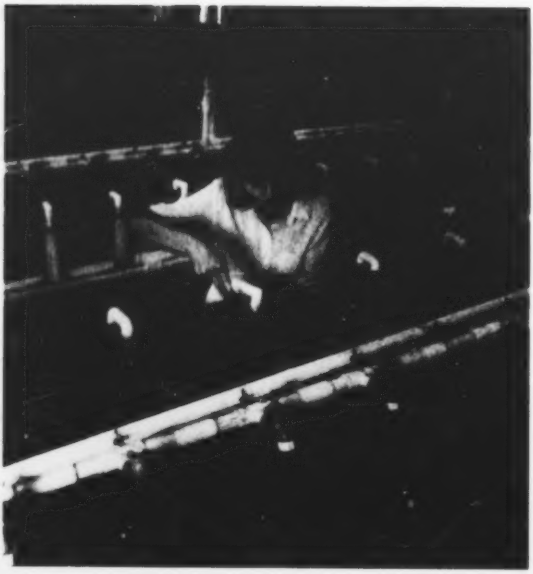
Sea Grant College Program
Massachusetts Insitute of Technology
E38-302
Cambridge, Mass. 02139

Woods Hole Sea Grant Program
Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543

Michigan Sea Grant Program
University of Michigan
2200 Bonisteel Boulevard
Ann Arbor, Mich. 48109-1138

Minnesota Sea Grant Program
116 COB
1994 Buford Avenue
St. Paul, Minn. 55108

Mississippi/Alabama Sea Grant Consortium
Caylor Building
Gulf Coast Research Laboratory
Ocean Springs, Miss. 39564



New Hampshire Sea Grant Program
Marine Program Building
University of New Hampshire
Durham, N.H. 03824

New Jersey Marine Science Consortium
Sea Grant Program
Building 22
Fort Hancock, N.J. 07732

New York Sea Grant College Program
411 State Street
Albany, N.Y. 12246

North Carolina Sea Grant College Program
Box 8605
North Carolina State University
Raleigh, N.C. 27695-8605

Ohio Sea Grant Program
The Ohio State University
484 West Twelfth Avenue
Columbus, Ohio 43210

Oregon Sea Grant College Program
ADS A418
Oregon State University
Corvallis, Ore. 97331

Puerto Rico Sea Grant Program
Department of Marine Sciences
University of Peurto Rico
Mayaguez, P.R. 00708

Rhode Island Sea Grant College Program
Marine Advisory Service
University of Rhode Island
Narragansett, R.I. 02882

South Carolina Sea Grant Consortium
207 Meeting Street
Charleston, S.C. 29401

Texas Sea Grant College Program
Texas A&M University
College Station, Tex. 77843-4115

Virginia Sea Grant College Program
Virginia Institute of Marine Sciences
Gloucester Point, Va. 23062

Washington Sea Grant College Program
University of Washington
3716 Brooklyn Avenue NE
Seattle, Wash. 98105

Wisconsin Sea Grant Institute
University of Wisconsin
1800 University Avenue
Madison, Wisc. 53705

National Sea Grant College Program
Office of Sea Grant
6010 Executive Boulevard
Rockville, Md. 28052

New England Marine Advisory Service
University of Rhode Island
Narragansett Bay Campus
74 Lower College Road
Narragansett, R.I. 02882

National Sea Grant Depository
Pell Library
University of Rhode Island
Bay Campus
Narragansett, RI 02882

Degree Programs

Information about educational opportunities can be obtained from those institutions that offer degree programs in the field. The ten JOI institutions are listed below. Addresses for other institutions are available from brochures from AGU, IEEE, MTS and the Naval Oceanographic Office.

Marine Programs
University of Hawaii at Manoa
Honolulu, Ha. 96822

Lamont-Doherty Geological Observatory
of Columbia University
Palisades, N.Y. 10964

Rosensteil School of Marine and Atmospheric
Sciences
University of Miami
Miami, Fla. 33149

School of Oceanography *or* School of Engineering
Oregon State University
Corvallis, Ore. 97331

Graduate School of Oceanography
Narragansett Bay Campus
University of Rhode Island
Narragansett, R.I. 02882
or
Department of Ocean Engineering
University of Rhode Island
Kingston, R.I. 02881

Scripps Institution of Oceanography of the University
of California
La Jolla, Calif. 92093

Department of Oceanography *or*
Ocean Engineering Program
Department of Civil Engineering
Texas A&M University
College Station, Tex. 77843

Institute for Geophysics *or*
Department of Marine Studies
College of Engineering
The University of Texas at Austin
Austin, Tex. 78712

School of Oceanography *or*
Ocean Engineering Program
University of Washington
Seattle, Wash. 98195

Woods Hole Oceanographic Institution
Woods Hole, Mass. 02543

Conclusion

It has been suggested that the purpose of science is "to know." It is certainly true that a major purpose of oceanography is to describe and understand the world's oceans. New discoveries and ideas have recently come from oceanographers at an accelerating pace. New technologies make it possible to measure oceanographic parameters on time and space scales not previously available.

Knowledge of the relationship of the ocean to mankind, the weather and climate; availability of resources from the ocean; and use of the ocean in transportation, defense, and even waste disposal are all goals of oceanographers as is development of an understanding of the impact on the oceans of human activity. What is the relationship between ocean events, such as El Niño, and worldwide weather patterns? Is world climate warming as a result of the "greenhouse effect," and what is the role of the oceans in relation to atmospheric gases that control this effect? What new foods, drugs and mineral resources can mankind extract from the oceans? How can our nation better use the oceans in our national defense, and how can all nations better use the transportation and resource potential of the oceans to promote peace and human welfare? How can we ensure optimum use of the oceans while minimizing harm to them?

These are questions that will not be answered in this publication. Their answers await the energetic efforts of a talented new generation of oceanographers.

About the Author

Dr. Anderson is a professor of physical oceanography at Texas A&M University. He was educated in physics at Baylor University and in engineering acoustics at The University of Texas at Austin.

Prior to his present appointment, Dr. Anderson worked as a research scientists for twelve years at the Applied Research Laboratories of The University of Texas and for ten years in several research and administrative capacities at U.S. Navy laboratories, including the Naval Ocean Research and Devleopment Activity and the Office of Naval Research.

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